General Procedure for Manufacturing SWISS CHEESE

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General Procedure For Manufacturing Swiss Cheese[1]

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INTRODUCTION

Swiss cheese is one of the most difficult kinds of cheese to make. The successful manufacture of Swiss cheese of good quality, suitable for merchandising, is strictly a factory operation that requires special equipment and experienced help. It is not advisable, therefore, to attempt to make Swiss cheese on a small scale in the home.

Control of the quality and composition of the milk, the propagation and use of the essential bacterial starters, and the details of

[1] The authors acknowledge the helpful assistance of Robert E. Hardell, formerly with the Bureau of Dairy Industry and now with Cheese Laboratory, Inc., Monroe, Wis. Photography by Charles A. Knell, former Press Service photographer, now with the Reclamation Service, U. S. Department of the Interior.

manufacture are complicated procedures that require the services of a skilled cheesemaker who has had special training and experience. Moreover, in the manufacture of Swiss cheese it is customary to use kettles that hold at least 2,000 pounds of milk each, and many cheesemakers use kettles that hold from 3,000 to 3,200 pounds. And the cheese made from each kettle may weigh from 160 to 230 pounds. Most buyers refuse or grade down a cheese weighing less than 140 pounds.

The following description of the manufacturing process is intended for those who have only limited experience and also for those who want general information about the manufacture of Swiss cheese in this country. Those who want to learn the more intricate details of the process are advised to obtain such knowledge first-hand by working under the direction of an experienced and successful cheesemaker.

The illustration on the cover shows a typical Swiss cheese of good quality.

REQUIREMENTS FOR ESTABLISHING A FACTORY

The factory should be located where an adequate supply of good-quality milk is available during at least 10 months of the year. It should be able to draw its milk supply from an area within 5 miles of the factory. If the milk is hauled a greater distance, facilities must be provided to keep it cool. The factory also should be near a market and on a good highway. It is customary to provide a home for the cheesemaker either above the factory or near it.

The factory operator will find it more desirable to obtain milk from farms producing 200 or more pounds of milk daily, rather than from farms producing smaller quantities. When milk is obtained in large-unit quantities it is easier to maintain its quality, and the labor of handling and testing it in the factory is reduced. Moreover, a farmer who produces a large quantity of milk is better able to afford the expense of installing the necessary equipment for cooling the milk on the farm and for cleaning and sterilizing the utensils.

At least 5,000 pounds of milk a day is considered necessary for the economical, profitable operation of a Swiss-cheese factory. Two kettles will be needed for handling this quantity, and two cheeses can be made daily. The cost of the equipment for making Swiss cheese cannot be justified in a factory with less than two kettles. Moreover, additional equipment should be available to handle the increased supply of milk during the flush season, when the supply may be at least doubled.

To allow for future growth and expansion, the size of a new factory and the capacity of its equipment—especially the manufacturing room, the two curing rooms, and the steam boiler and the refrigeration plant—should be at least 30 percent larger than the anticipated initial requirements. A modern, well-equipped factory should include the following rooms and equipment:

1. A receiving room, with scales, metal strainer, weigh can, receiving vat, can washer, and facilities for sampling the milk.

2. A manufacturing room, with separator and clarifier, small whey tank, cooler, copper kettles, press table and presses, wash sink, power equipment, tracks or portable truck-hoist for dipping, and a cooling tank with running cold water. If whey butter is to be made for the patrons, a churn is necessary.
3. A power room, with a large steam boiler, a steam engine (if electric power is not available), and a steam-pressure sterilizer or autoclave. A lavatory with shower bath is desirable.
4. A cold cellar, to be kept at 55° to 60° F. An artificial refrigerating unit is usually necessary to help maintain the proper temperature. The cold cellar should be well insulated and may be at least partly underground, either as a basement or dug into a hillside. Equipment in the cold cellar should include a brine tank large enough to hold the number of cheeses manufactured in 3 days during the milk-flush period, with the cheeses only one deep in the tank the first day and not more than two deep the second and third days. There should be enough shelf room to accommodate the make for at least 3 to 4 weeks of the milk-flush period. As the diameter of the average cheese board is 36 inches, about 38 inches should be allowed for each cheese in estimating both the length and the width of the shelves. The vertical distance between shelves varies with the style of cheese being made but is generally 12 inches. The shelves are usually in tiers of 7 to 9. A tiered table, on which the cheeses are washed, is also necessary.
5. A warm, or fermentation, cellar. The warm cellar should be as well insulated as the cold cellar. Equipment should include a stove or other heating facilities adequate for maintaining a temperature of about 72° F. at all times of the year. The top of the stove should be large enough to hold a large pan of water to help keep the relative humidity of the cellar at 80 to 85 percent, or else some other means of maintaining this relative humidity should be provided. The shelves should hold the cheeses made during 6 to 8 weeks. A table for washing the cheeses should be included unless the one in the cold room can be moved in.
6. Laboratory room, with an incubator for starter cultures, equipment for transferring and carrying cultures, a Babcock tester, facilities for determining acidity and making the methylene-blue-reduction test, and other laboratory equipment.
7. Office and salesroom, for keeping records and selling cheese at retail.
8. Whey tank, which should be placed outside of the factory.
9. Storage room, for supplies and idle equipment.
10. Additional supplies and equipment include: Milk pumps, sanitary piping, mechanical stirrers, cheese harps, basket stirrers, baffle boards or brakes, scoops, dippers, cans, pails, hand stirrer, steam hose, water hose, kettle thermometers, cheesecloth, circles and bandages, hoops, and cheese boards.

QUALITY OF MILK

Good-quality milk is essential in the manufacture of Swiss cheese. The milk must be fresh. Milk that has been held for 24 hours, even at a low temperature, is less suitable than milk that has been held for 12 hours. The milk must be clean, that is, it must be free from extraneous matter and gross bacterial contamination. The methylene-blue-reduction time of the milk should be between 3 and 6 hours. Thus, some slight ripeness of the milk apparently is desirable, but there should not be any appreciable increase in the titratable acidity. It is especially important that the milk be as free as possible of gas-producing bacteria. A sample of the milk, held in a sterilized test tube or small bottle at 98° to 100° F. for 12 to 18 hours, should form a smooth curd without the presence of gas bubbles.

It is especially important to the cheese-factory operator to make certain that all patrons deliver good milk. He should advise his patrons regarding approved sanitary practices in the production and care of milk on the farm. The milk pails and cans should be rinsed, washed thoroughly, and scalded immediately after use, and then should be placed on a rack in an inverted position where they will drain and dry quickly. The cans in which whey is transported from the factory to the farms should be cleaned thoroughly and then scalded before they are used for holding or delivering milk. Likewise, all other equipment that comes in contact with the milk—both on the farm and in the factory—should be cleaned thoroughly and scalded or, preferably, steam-sterilized after use. Treating the clean containers with a chlorine disinfecting solution and then rinsing them thoroughly with water just before use is an additional effective sanitizing practice. It is necessary for the producers to cool the evening milk promptly and to keep it cold overnight, and it is advisable to have them deliver the evening milk and the morning milk in separate cans. The evening and the morning milk should be delivered early in the morning, and manufacture of the cheese should begin promptly.

Milk from cows that have mastitis should not be used for making cheese. It is abnormal in composition and properties. In particular, it coagulates slowly with rennet and forms a relatively soft curd. Such milk should be rejected until adequate tests show that the cows have recovered completely.

Milk from mastitis-infected cows whose udders are being treated with penicillin, aureomycin, or other antibiotics usually contains enough of the therapeutic agent to inhibit normal starter growth. Use of milk from cows while they are being treated has been found to be a troublesome cause of failure in cheesemaking. Therefore, milk from treated cows must not be used for making cheese until starter bacteria will again grow in it normally. With some treatments, the milk must not be used until at least the fourth milking after the last treatment; and with others, until at least the fifth milking afer the last treatment. The length of time cannot be stated definitely because it depends on the kind of treatment and other related factors.

More complete information on the production of clean, good-quality milk is given in Farmers' Bulletin 2017, Clean Milk Production, which can be obtained by writing to the Bureau of Dairy Industry.

STARTERS AND THEIR FUNCTIONS

Three species of bacteria are used as starters in manufacturing Swiss cheese. They are: A lactobacillus—*Lactobacillus bulgaricus* (*L. helveticus*) or *L. lactis*—commonly called the rod culture; *Streptococcus thermophilus*—commonly called the coccus culture; and *Propionibacterium shermanii*—a propionic-acid-forming micro-organism—commonly called the eye former.

Functions of the Starters

All three of these types of bacteria, which have been found consistently in Swiss cheese, are essential in its manufacture.

The principal function of the lactobacillus and streptococcus starters during manufacture is to produce lactic acid by fermenting the lactose. The acid thus formed aids in expelling the whey from the cheese in the press. These bacteria also retard the growth of undesirable micro-organisms. They—especially the lactobacilli—probably contribute, either directly or indirectly, to the breakdown of the curd during the ripening of the cheese.

The propionic-acid bacteria are generally believed to be largely responsible for the characteristic flavor and eye formation.

The lactobacilli are probably the most important micro-organisms that must be added as a starter, because this group rarely occurs naturally in sufficient numbers—either in the milk or on the cheese-making equipment—to carry on their essential acid-producing and ripening functions in the cheese-making process. *Streptococcus thermophilus* and propionic-acid bacteria, on the other hand, usually are present in the milk and persist readily on the equipment. *S. thermophilus* especially is essential for producing acid during the first 6 to 8 hours while the cheese is in the press, before the lactobacilli begin to grow actively and produce acid in the cheese. It is during the first few hours in the press that *S. thermophilus* performs its principal functions, namely, aids in expelling whey and counteracts the growth of gas-forming bacteria that have survived the cooking in the kettle.

The strains of these starter bacteria that are used must be sufficiently heat-resistant to survive for an hour or somewhat longer the unusually high temperatures at which Swiss-cheese curd is cooked—temperatures in the range of 120° to 127.5° F. And the two types that are depended on to produce acid must be capable of growth at temperatures between 115° and 120°.

Some cheesemakers add the propionic-acid or eye-former culture to the kettle milk regularly; others use it infrequently or only when it is readily available. In factories in which it is not used regularly, but in which the cheese develops characteristic eyes and flavor, it may be assumed that the milk contains enough organisms of this type. Although it is probable that most milk used in making Swiss cheese contains at least small numbers of propionic-acid bacteria, there is evidence that both the eye formation and the flavor are improved by adding this culture regularly to the milk.

The cultures mentioned above usually can be obtained from laboratories in Swiss-cheese producing areas; they are available by purchase from the American Type Culture Collection, 2029 M Street NW., Washington 6, D. C.; and they may be available also from agricultural experiment stations in States where Swiss cheese is made.

Propagating the Starters

Pure cultures of the lactobacilli and of *Streptococcus thermophilus* are propagated as so-called "mother cultures" in sterilized milk. The milk may be sterilized conveniently in 125-milliliter flasks with cotton stoppers, or in 6-ounce bottles with screw caps. Bulk starters to be added to the kettle milk are made from the mother cultures. They are prepared generally in sterilized milk; however, they may be prepared in sterilized whey. The milk or whey for bulk starters is sterilized usually in enameled kettles, each holding about 1 gallon and fitted with a cover. Sterilization is accomplished by heating in a steam sterilizer at 15 pounds' pressure. The time required depends on the volume of milk or whey in each container. For example, 1 pint or less requires 15 minutes; 1 quart, 20 minutes; 2 quarts, 35 minutes; 1 gallon, 60 minutes; and larger volumes correspondingly more time. Milk or whey that has been sterilized properly will be only very slightly brown in color. A distinctly brown color indicates that the time of sterilization was too long. Milk or whey that has been oversterilized is less suitable for active growth of the starter bacteria. Therefore, the small volumes of milk to be used for mother cultures should be sterilized apart from the larger volumes to be used for bulk starters, and for a correspondingly shorter period.

The pipettes used for transferring and inoculating cultures should be cleaned thoroughly, placed in a closed container, and sterilized by heating (preferably in a hot-air sterilizer) at not less than 320° F. for an hour, or in an autoclave at 15 pounds' steam pressure for 30 minutes. The sterilized pipettes should be removed from the pipette containers one at a time and only at the time of inoculation. They should be held in the hand, not laid on the table. The end that comes in contact with the sterile milk or culture should not be allowed to touch the fingers or any other nonsterile object. Likewise, the openings of the flasks, bottles, or tubes containing sterile milk or culture should not be exposed to the air or to contamination by dust longer than is necessary for the inoculation. Thermometers and nonsterile pipettes should not be placed in the sterile milk or culture. The amount of culture to transfer varies with the activity of the starter and the period of incubation.

The freshly inoculated mother cultures should be incubated at 98° to 100° F. for 18 hours or until the milk has curdled. Then they should be stored at 55° to 60° until they are transferred into freshly sterilized milk. New transfers should be made daily or at least three times weekly. Some cheesemakers prefer to propagate these cultures with a mycoderma. Cultures propagated with a mycoderma retain their activity longer, and therefore new transfers need to be made only twice or even once weekly. Reserve cultures should be maintained for use in case of loss, contamination, or decrease of activity of the regular culture. Dairy laboratories in Swiss-cheese producing areas sometimes grow and dispense the mother cultures in small dropper bottles, for use in inoculating bulk starters.

Following sterilization, the milk or whey for bulk starters should be cooled to 98° to 100° F. It then should be inoculated with the mother culture and kept in an incubator or water bath at 98° to 100° until it curdles and the desired acidity has developed (16 to 18 hours). Then it is ready for use.

Many cheesemakers use a pasteurized-whey starter. Each day the whey for this starter should be removed from the kettle immediately after the curd is dipped, or after harping. It should be heated quickly to a temperature between 140° and 158° F., then cooled to between 110° and 120°, and held in an incubator for 17 to 20 hours at 98° to 100°. Some cheesemakers inoculate this pasteurized-whey starter with lactobacilli and streptococci before incubation, and some inoculate it with propionic-acid bacteria. After incubation, the acidity of the uninoculated whey starter is usually between 0.55 and 0.65 percent and that of the inoculated starter may be 0.75 percent.

The propionic-acid bacteria do not increase significantly in numbers in the cheese until the cheese is placed in the warm room. Therefore it is not essential for this culture to be in a condition to initiate active growth as soon as it is added to the milk. It usually is prepared in a broth medium containing 0.5 percent of lactose and either 3 percent of peptone or 1 percent of peptone and 1 percent of tryptone. It should be incubated for 5 to 7 days at a temperature between 80° and 90° F., and then stored at approximately 60° until used. It is in the best condition for use when 2 to 6 weeks old. The preparation of this culture in suitable condition for use is too difficult to attempt in most cheese factories.

THE MANUFACTURING PROCESS

The manufacturing process includes the following steps.

Inspecting the Milk

Inspect the milk when it is received. Reject any can of milk that shows evidence of undesirable odor or flavor, developed acidity, or the presence of extraneous matter.

Clarifying the Milk

It is advisable to clarify the milk that is to be used for making Swiss cheese. Clarification (subjecting the milk to centrifugal force as it passes through a clarifier bowl revolving at a rapid rate of speed) removes sediment, disperses clusters of fat, increases the elasticity of the curd in the cheese, and reduces the "set," or the number of eyes in the cheese, thus greatly improving the eye formation.

The milk may be clarified by using a clarifier or by using a cream separator that is equipped with a special clarifier bowl. Or the milk may be run through a regular cream separator. However, it is better to use a clarifier.

Most cheesemakers clarify the milk at the temperature at which it is received; some warm the milk to 70°–75° F. in cool weather. Experiments in the Bureau of Dairy Industry have shown that there is greater improvement in eye formation when the milk is clarified at higher temperatures—even as high as 90°—than when it is clarified at 80° or lower, but sometimes excessive foaming at 90° makes it necessary to use a lower temperature.

A forewarmer should be installed to warm the milk as it passes from the receiving vat to the clarifier. The milk flows through a

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pipe or trough from the clarifier or separator directly to the cheese kettles.

Standardizing the Milk

It usually is desirable to standardize the milk so that the cheese will contain slightly more than 45 percent of fat in its dry matter—a percentage generally favorable for the best quality. This percentage also conforms with legal requirements.

The percentage of fat in the kettle milk should be between 2.8 and 3.5, depending on the composition of the original milk. Usually slightly more than 10 percent of the fat in the milk should be removed, but this varies in different factories. With high-testing milk the proportion is higher, and with low-testing milk it is lower; but some of the fat must be removed always, if cheese of uniform composition is to be made. For example, the percentage of fat in 4-percent milk may be reduced to approximately 3.4; that in 3.5-percent milk, to 3.0; and that in 3.2-percent milk, to 3.0 or 2.9. However, less fat should be removed when there is excessive fat loss in the whey, such as may occur even with milk of low fat content.

Samples of pressed curd from the kettle can be analyzed, and samples of the cheese should be analyzed, and subsequent standardization should be corrected if necessary.

Milk may be standardized either by separating a portion of the milk and adding the skim milk to the contents of the kettle, or by withholding a portion of the cream that flows from the cream spout during clarification with a cream separator. With either method, it is necessary to determine the quantity of cream of a definite percentage of fat that is to be removed in order to standardize the milk to the percentage of fat that has been found by experience to yield the desired percentage of fat in the cheese.

The following example shows how to determine the quantity of 40-percent cream that must be removed from 1,000 pounds of milk containing 4 percent of fat to obtain 3.4 percent of fat in the milk—a reduction of 0.6 percent: $\frac{0.6 \times 1{,}000}{40} = 15$ pounds of 40-percent cream to be removed.

Adding the Starters

As the milk flows from the clarifier into the kettle, turn steam on in the jacket or steam chamber under the kettle to begin to warm the milk to the setting temperature and start the mechanical stirrer operating at 38 to 40 revolutions per minute. Add the starters when the kettle is full or nearly full, shortly before setting the milk with rennet. (See fig. 1.) The quantity of each starter to use depends on whether the starters are grown in milk or whey and on the quantity of milk in the kettle and the "activity" of the milk. The following quantities of starters should be added to a kettle containing about 2,500 pounds of milk: (1) Usually ½ to 2 pounds of either a skim-milk or a whole-milk starter, or 1 to 4 pounds of a whey starter, of lactobacillus or rod culture; (2) usually the same quantity of milk or whey starter of *Streptococcus thermophilus* or coccus culture; and (3) usually ½ to 2 ounces of a broth culture or *Propionibacterium shermanii*.

Setting the Milk

Continue to warm the milk until it reaches a definite setting temperature in the range of 88° to 94° F. Then, with the stirrer still operating, set the milk with rennet extract at the rate of 1½ to 3 ounces per 1,000 pounds of milk. Use enough rennet so that the first indication of thickening appears in from 20 to 22 minutes and so that the

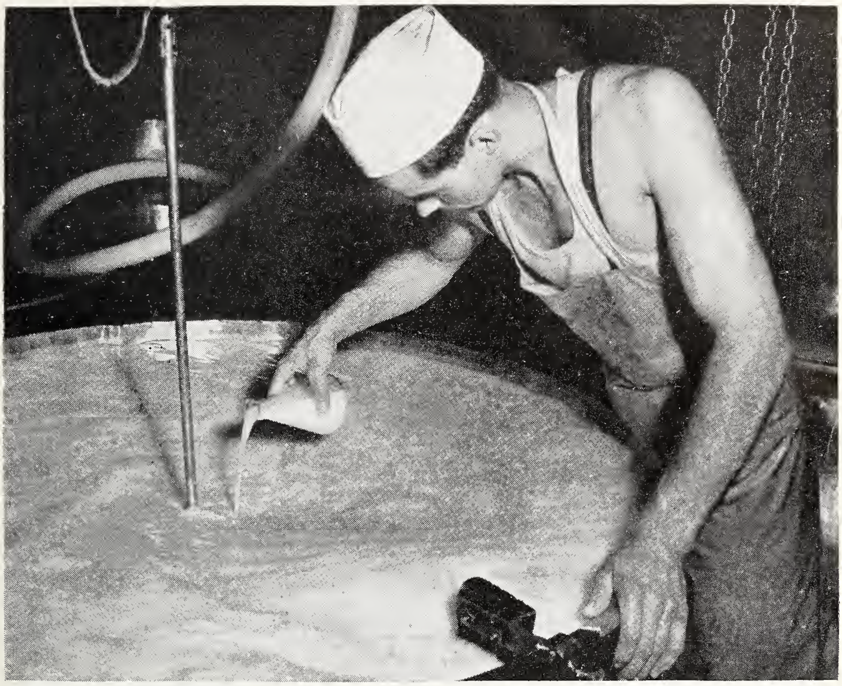

Figure 1.—Adding the starter to the milk in the Swiss-cheese kettle.

curd is firm enough to cut in 30 minutes. Dilute the rennet in about 40 times its volume of water before adding it to the milk.

After mixing, stop the stirrer, remove it, and use the scoop to stop the motion of the milk.

The curd is ready for cutting when it splits evenly ahead of the finger, or a blunt instrument, inserted at an angle into the curdled milk and raised slowly.

Cutting the Curd

As soon as the curd is sufficiently firm to begin cutting, skim the creamy portion on top with a wide, flat scoop and lay it over to the back of the kettle. This is called "turning the surface under" and is illustrated in the background in figure 3. Then cut the curd with a Swiss-cheese harp. Insert the harp and draw it forward and backward and then from side to side through every portion of the curd,

thus cutting it into long vertical pieces about 1 inch square. The curd is being cut with a harp in the rear-center kettle in figure 2.

Inverting or Turning the Curd

Pull the curd on top gradually forward with successive strokes of the scoop, and thus turn it under. Cut the largest pieces with the scoop. Continue this pulling until all the curd has been turned under from top to bottom and the long pieces have been cut or broken as uniformly as possible into cubes.

Harping the Curd

Begin harping the curd usually not more than 5 minutes after cutting. Move the harp to and fro with an elliptical motion, slowly at first and more rapidly later, rotating and mixing the curd as the particles are being cut. Shortly after beginning to harp the curd, fasten the brake (a flat, wooden or preferably metal board) inside the kettle at one side, to retard the circular motion of the curd and to increase the mixing effect. Leave the brake in place until the curd is ready to dip.

Continue harping until the particles are about ⅛-inch in diameter—slightly larger than grains of wheat—and are nearly uniform in size.

Figure 2.—Measuring the rennet (right), which will be diluted with water and added to the milk being stirred in the kettle (foreground); cutting the curd (rear center).

FIGURE 3.—Turning the surface under (background); harping the curd (left); testing the curd preparatory to dipping (right).

This will usually take not more than 10 to 15 minutes from the time of cutting. Harping is illustrated at the left in figure 3.

FOREWORKING THE CURD

The working of the curd after harping until it is ready to cook is known as "foreworking." This may take only 30 minutes, or even less with ripe or "fast-working" milk, but it may take an hour or more if the curd acquires firmness slowly.

Most cheesemakers operate the mechanical stirrer continuously during this period, at about 40 revolutions per minute. Some cheesemakers, however, let the curd settle for about 5 minutes and then draw off some of the whey. Some repeat the settling process one or more times. If the curd is allowed to settle, it should be mixed thoroughly with the harp before the mechanical stirrer is put into operation.

During foreworking the curd particles shrink in size, expel whey, and acquire additional firmness.

To determine when the curd is ready to cook, test it by rubbing a portion between the fingers. It should feel fairly firm at the beginning of the cooking process.

COOKING THE CURD

Turn steam on in the jacket or in the steam chamber under the kettle, and heat the curd—usually for 30 minutes—to a temperature in the

FIGURE 4.—Dipping the curd.

range of 120° to 127.5° F. Stir the curd continuously. Increase the temperature about 5° each 5 minutes during the first 10 or 15 minutes, and somewhat more rapidly during the last part of the cooking period.

Stirring the Curd

When the final cooking temperature is reached, turn off the steam and continue stirring (usually for at least 25 minutes but sometimes for an hour or even longer) until the curd is sufficiently firm and crumbly. This stirring of the hot curd is known as "stirring out."

As soon as a sample of the curd compressed firmly in the hand can be broken apart easily without sticking, and the particles separate readily when rubbed between the palms, the curd is ready to be dipped. The curd is being tested at the right in figure 3.

At this point some cheesemakers add several gallons of cold water.

Remove the stirrer and the brake, and let the curd settle. Some of the whey may be drawn off.

Dipping the Curd

Use a large, coarsely woven dipping cloth to dip the curd. Wrap a thin, flexible steel strip securely in one edge of the cloth, and pass the edge thus supported under the entire mass of curd—from back to front—meanwhile holding the opposite corners of the cloth in such a way that the cloth forms a large bag. Thus the curd is enclosed in the cloth without being broken up or turned over.

Usually two people do the dipping, each holding an end of the metal strip in one hand and a corner of the cloth in the other. (See fig. 4.)

However, it can be done by one person holding one end of the metal strip in each hand and the other two corners of the cloth between his teeth, meanwhile bracing his feet and leaning over the kettle.

After the curd is enclosed in the cloth, remove the metal strip and draw together and tie the corners of the cloth. Then, with a block and tackle, hoist the curd slowly from the kettle and let the excess whey drain into the kettle. (See fig. 5.) The curd may be dipped a second time. Transfer the small quantity of curd removed in the second dipping to the next kettle to be dipped.

Pressing the Curd

Lower the bag of curd into a circular wooden or stainless-steel hoop (which has been placed on a circular pressboard on a drain table) and remove the tackle. Twist the cloth and hold it together to keep open cracks from forming in the curd. Meanwhile, press the top of the cheese gently to the shape of the hoop (with the palms of the hands), so that pockets of whey can drain from the surface. Fold the edges of the cloth smoothly over the curd, raise the hoop slightly to permit free drainage of whey, and cover the cheese with a circular pressboard or lid. Then apply pressure from above by means of a screw or lever press, as shown in figure 6.

Figure 5.—Hoisting the curd out of the kettle.

Dressing and Turning the Cheese

After the cheese has been in the press for about 5 minutes, remove the hoop; spread out the dipping cloth; place a clean, light cloth and a clean, heavy burlap cloth on the cheese; replace the hoop; and turn the cheese over onto a pressboard. Then remove the dipping cloth, fold over the other cloths, and place another pressboard on top of the cheese.

Following the first pressing, dressing, and turning, re-dress and turn the cheese at definite intervals. It formerly was customary to press the cheese continuously after each turning until the next morning, increasing the pressure gradually. However, many cheesemakers now follow this general practice: (1) Press the cheese for about 5 minutes after dipping; (2) re-dress, turn, and leave it covered with a pressboard—without pressure—for 4 hours; (3) re-dress, turn, and press for 2 hours; (4) re-dress, turn, and press for 3 hours; and (5) press overnight with no dressing other than a flat layer of burlap on the top and bottom of the cheese.

If the curd is excessively dry at dipping, starched fabric circles may be placed on the top and bottom surfaces to help prevent rind cracking.

If the cheese is too soft and tends to flatten in the curing room, a cloth bandage may be wrapped around its circumference as a support.

The acid produced by the starter organisms, the warmth of the cheese, the regular turning and re-dressing with clean, dry cloths, and

Figure 6.—Pressing the curd in the hoop with a screw press suspended from above.

FIGURE 7.—The cheesemaker puts a cheese in the salt tank.

the pressure should expel whey uniformly and cause the curd to knit into a compact mass, free of mechanical openings and pockets of whey.

The temperature of the manufacturing room should be about 75° F. and not less than 70°. In making good cheese it is important to prevent rapid cooling. The surface of the cheese cools much more rapidly than the interior. The temperature of the curd usually is between 120° and 122° at dipping. Five hours later, the temperature immediately beneath the surface will be about 15° lower than that in the interior, and the next morning the difference will be 20° to 27°. Because of the cooling, lactic-acid fermentation (produced by the starters) is likely to occur at a relatively rapid rate at the surface of the cheese. Therefore, excessively rapid cooling of the surface, with accompanying production of acid and rapid matting of the curd, may interfere with the desired drainage of whey from the interior of the cheese.

Salting the Cheese

Label the cheese for identification when it is removed from the press, and then take it to the cold room (where the temperature should be about 55° F. and the relative humidity should be from 80 to 85 percent). If the salt brine can be kept cold, the usual procedure is to place the cheese in the salt tank at once, where it floats in a solution of approximately 23 percent of salt (sodium chloride) in water. However, it may be left in the hoop on a shelf to cool for a day before it is placed in the salt tank. (See fig. 7.)

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Leave the cheese in the salt solution for 2 or 3 days, the time depending on the size of the cheese and the extent of salt absorption and rind formation desired. Turn it over and sprinkle it with salt daily. Then place it on a shelf and keep it in the cold room for an additional week or 10 days. In the cold room, as well as later in the warm room, sprinkle the cheese with dry salt every time it is washed and turned.

Curing the Cheese

Following the preliminary period in the cold room, place the cheese on a clean cheese board on a shelf in the warm room (where the temperature should be within a range of 68° to 74° F. and the relative humidity should be from 80 to 85 percent). Here the cheese undergoes the principal ripening process.

At first, place the cheese on a lower, cooler shelf. Two or three times weekly, during the entire process of curing or ripening, wash the

Figure 8.—Swiss cheese in the curing room. The cheesemaker is washing a cheese, preparatory to sprinkling it with salt.

cheese with a clean cloth (which has been dipped in salty water), turn the cheese over, rub it nearly dry, place it on a clean board, and sprinkle it with fine dry salt. (See fig. 8.)

The eyes should begin to form by the time the cheese has been in the warm room for 2 or 3 weeks, and eye formation should take place

at a slow, uniform rate. If a cheese is rising and bulging too rapidly, sprinkle it more heavily with salt after each washing and keep it on the lower shelves. This retards the rate of rise. When the cheese has risen sufficiently (usually after 4 to 6 weeks in the warm room), return it to the cold room for further but slower curing.

Following the curing period in the cold room, the cheese is ready to be graded and sold. It is graded either by the buyer or by a State grader and is sold usually to a wholesaler, who may cure it for an extended period at a temperature as low as 40° F. Cheese that is to be shipped is packed in large circular wooden boxes or tubs of correct size to fit the cheese—generally four wheels in a tub.

COMPOSITION AND YIELD

Typical data for the composition of Emmentaler or imported Swiss cheese are as follows: Moisture, 34.5 to 36.5 percent; fat, 29.5 to 30.5 percent; protein, 27 to 28 percent; ash, 3 to 5 percent; and salt, 1 to 1.4 percent. Analyses of 1,342 wheels of domestic Swiss cheese made from standardized milk containing an average of 2.85 percent of fat showed the following average values: Moisture, 39.37 percent; fat, 27.53 percent; and fat-in-dry-matter, 45.41 percent. Other analyses of fewer samples showed the following average values: Protein, 27.4 percent; ash, 3.8 percent; and salt, 1.05 percent.

The yield of cheese varies between 7 and 8 pounds per 100 pounds of standardized milk, depending on the composition of the milk when it is received and the extent to which it is standardized.

Using Whey and Butterfat Byproducts

The butterfat that is removed from the milk when it is standardized for Swiss-cheese manufacture may be sold as cream or it may be made into butter.

Approximately 90 pounds of whey, containing approximately 0.7 percent of fat, remains as a byproduct from each 100 pounds of standardized milk used in the manufacture of Swiss cheese. The whey may be separated and the whey cream made into butter. Whey cream that can be used in almost any way that ordinary cream is used can be made by first separating the whey to yield whey cream containing approximately 60 percent of fat and then standardizing the cream to a lower percentage of fat with either whole or skim milk.

In many factories the income from sale of butterfat—either as cream or butter—is sufficient to pay the operating expenses of the factory.

The fat-free whey contains generally from 4.5 to 4.8 percent of lactose, approximately 0.7 percent of protein—principally albumin—and also minerals and vitamins. It is often returned to the farms for use as stock and poultry feed. In large factories, it may be concentrated or dried. The concentrated or dried whey can be used as a component of various foods, such as confections, sherbets, cheese foods, and bakery goods, or as stock and poultry feed. The lactose in fluid whey can be removed and used commercially. The whey protein can be removed and used for human food or as animal feed.

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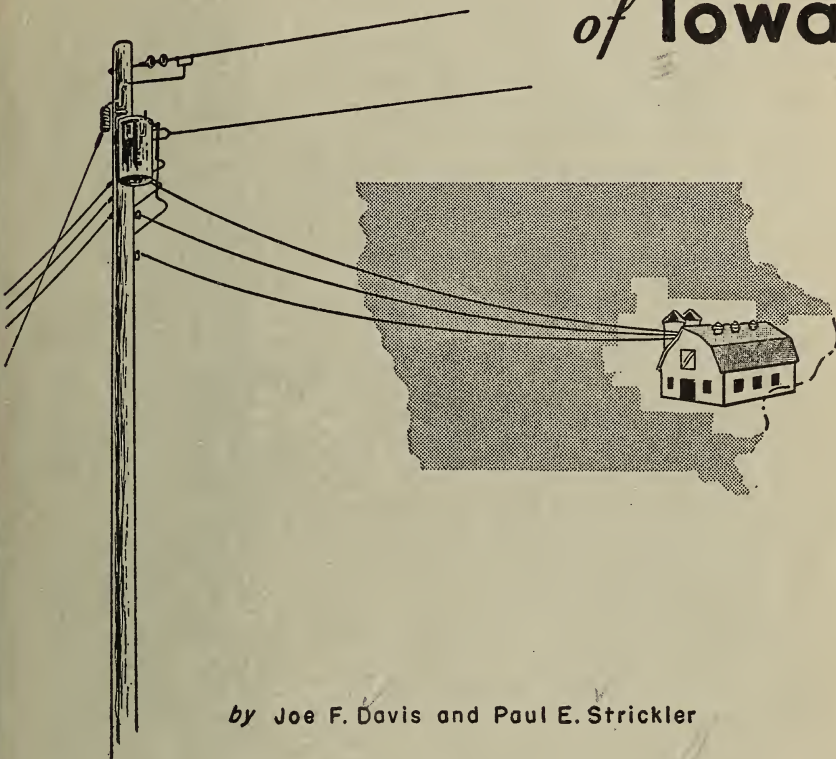

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